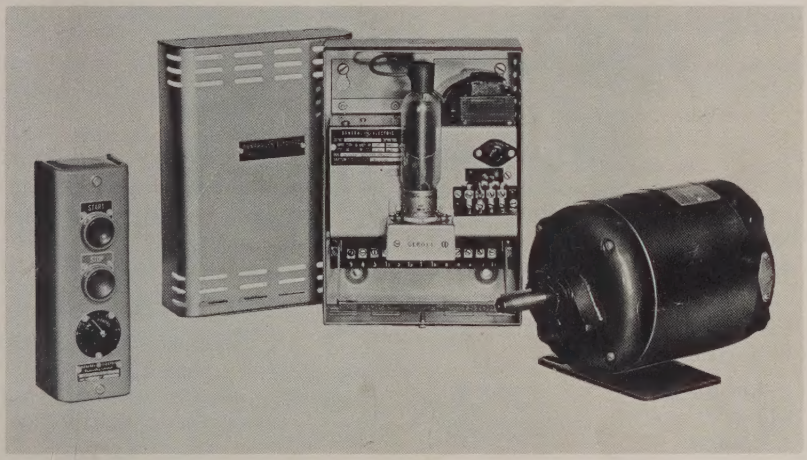
INSTRUCTIONS

GEJ-2582B
Supersedes GEJ-2582A

Half-Wave THYMOTROL* Drives

3S7507FC

*Trade-mark of General Electric Company



DESCRIPTION

Your basic Thymotrol drive consists of a motor, a controller and a control station. Drives with modifications and optional features are described in a later section.

MOTOR

The motor is a d-c shunt motor of a design suitable for use with the controller furnished. It may be of any rating through one horsepower, and may include a gear box, depending on how you ordered it. It has been lubricated at the factory for two years of normal operation.

CONTROLLER

The controller converts the alternating current (a-c) from the power line to direct current (d-c) to drive the motor.

CONTROL STATION

The basic control station includes a "Start" button, a "Stop" button and a "Speed" knob.

PERFORMANCE

You can control the speed of the motor from the speed shown on the motor nameplate down to standstill by turning the "Speed" knob. The motor will run smoothly and the speed will not be affected by more than three percent of the nameplate speed with chan load up to rated load at any spe tween nameplate speed and 1/20 s

PROTECTION

Unless specified otherwise, the troller incorporates UL-listed Fuse protection.

M1692SX
Electronic Services, Los Angeles

GENERAL ELECTRIC

TABLE OF CONTENTS

Page

DESCRIPTION 1
- Motor 1
- Controller 1
- Control Station 1
- Performance 1
- Protection 1

RECEIVING AND HANDLING 3

INSTALLATION AND ADJUSTMENT 3
- Mount the Motor 3
- Mount the Controller 3
- Mount Control Station 4
- Install Interconnecting Wiring 4
- Replace Removable Panel 5
- Make Proper Line Voltage Connection 5
- Install Tube 5
- Give Tube Initial Warm-up 5

OPERATION 5
- Initial Operation 5
- Normal Operation 5

MAINTENANCE 6
- Motor 6
- Controller 7

REPAIRS 7
- Motor 7
- Controller 7
- Replacing Printed-circuit Assembly 8
- Replacing Tube 9
- Replacing Transformer 9

MODIFICATIONS AND ACCESSORIES 9
- Transformers 10
- Reversing 10
- Jogging 10
- Overload Relay 11
- Protective Timer 11

APPENDIX A—PRINCIPLES OF OPERATION 12

APPENDIX B—SERVICING PRINTED CIRCUITS 14
- Circuit Tracing and Checking 14
- Replacing Components 14

RENEWAL PARTS LIST 16

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

RECEIVING AND HANDLING

As soon as the equipment is unpacked, you should examine it for any damage sustained in transit. If injury or rough handling is evident, a damage claim should be filed immediately with the transportation company, and the nearest Sales Office of the General Electric Company should be notified promptly.

The tube for the Thymotrol panel may be shipped in a separate carton. After examination, repack the tube in its original wrapping and carton for safe keeping. Avoid dropping the tube or placing it where it may be accidentally damaged. Reasonable care in the handling of the tube will be amply repaid in the length of tube life.

INSTALLATION AND ADJUSTMENT

MOUNT THE MOTOR

Refer to the drawing furnished with the motor for the location of mounting holes and over-all dimensions.

MOUNT THE CONTROLLER

Fold out the back cover of this booklet and refer to Fig. 18 before mounting the controller. (Fig. 18 shows a ¼-hp controller. Other sizes differ in minor details.)

Step 1—Remove cover from enclosure (if there is one) by loosening bottom screw (A) and lifting cover.

Step 2—Remove shipping screw (B).

Step 3—*VERY IMPORTANT!* Loosen holding screws (C).

Step 4—Press down on handle (D) to push panel loose from terminal board.

Step 5—Grasp shelf (E) with both hands and carefully slide panel along back of enclosure until "teeth" of printed circuit board (F) are clear of terminal board (G). Then lift panel off holding screws being careful not to damage "teeth." Set panel where it will not be damaged.

Step 6—Mount enclosure (or back panel if controller was ordered without enclosure) using hole locations and over-all dimensions shown in Fig. 1.

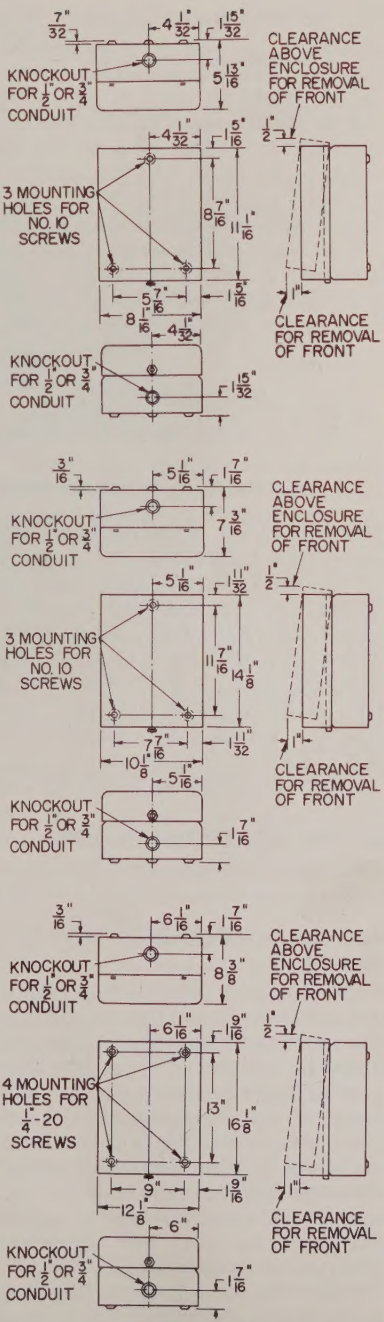

KNOCKOUT FOR 1" OR ¾" CONDUIT
CLEARANCE ABOVE ENCLOSURE FOR REMOVAL OF FRONT
3 MOUNTING HOLES FOR NO. 10 SCREWS
CLEARANCE FOR REMOVAL OF FRONT
KNOCKOUT FOR 1" OR ¾" CONDUIT
CLEARANCE ABOVE ENCLOSURE FOR REMOVAL OF FRONT
3 MOUNTING HOLES FOR NO. 10 SCREWS
CLEARANCE FOR REMOVAL OF FRONT
KNOCKOUT FOR 1" OR ¾" CONDUIT
CLEARANCE ABOVE ENCLOSURE FOR REMOVAL OF FRONT
4 MOUNTING HOLES FOR ¼-20 SCREWS
CLEARANCE FOR REMOVAL OF FRONT
KNOCKOUT FOR 1" OR ¾" CONDUIT

Fig. 1. Mounting dimensions.

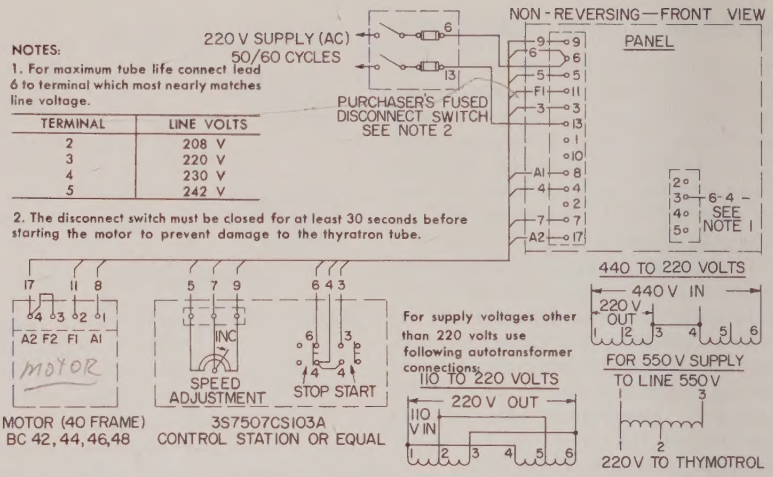

NOTES:
1. For maximum tube life connect lead 6 to terminal which most nearly matches line voltage.
TERMINAL | LINE VOLTS
2 | 208 V
3 | 220 V
4 | 230 V
5 | 242 V
2. The disconnect switch must be closed for at least 30 seconds before starting the motor to prevent damage to the thyratron tube.
220 V SUPPLY (AC) 50/60 CYCLES
PURCHASER'S FUSED DISCONNECT SWITCH SEE NOTE 2
NON-REVERSING—FRONT VIEW PANEL
6-4 - SEE NOTE 1
440 TO 220 VOLTS
440 V IN
220 V OUT
FOR 550 V SUPPLY TO LINE 550 V
220 V TO THYMOTROL
For supply voltages other than 220 volts use following autotransformer connections:
110 TO 220 VOLTS
110 V IN
220 V OUT
DC MOTOR (40 FRAME) BC 42, 44, 46, 48
3S7507CS103A CONTROL STATION OR EQUAL
SPEED ADJUSTMENT
STOP START

Fig. 2. Typical interconnection diagram for 3S7507FC100 series.

IMPORTANT: TEMPERATURE AROUND CONTROLLER WHILE IT IS OPERATING MUST BE BETWEEN 10 C (50 F) AND 40 C (104 F). FOR LONG AND RELIABLE SERVICE CONTROLLER MUST NOT BE SUBJECTED TO SEVERE SHOCK OR VIBRATION AND MUST BE KEPT FREE OF FOREIGN MATTER.

DO NOT INSTALL TUBE YET.

MOUNT CONTROL STATION

Mount control station at a convenient location using holes provided.

INSTALL INTERCONNECTING WIRING

Knockouts are shown in Fig. 1. Note that the controller contains Fusetron in one line only; fusing and disconnects should be installed in accordance with good electrical practice and applicable codes. A typical interconnection diagram is shown in Fig. 2. (The interconnection diagram furnished with the controller tells you how to make connections and what wire size to use on your particular unit.) The tag on the motor shows its connections.

Make all connections to the controller by bringing wires to the terminal board (G in Fig. 18).

Make all connections to the motor at the terminal studs which are covered by a removable plate.

Make connections to the control station by removing the cover and bringing wires to the terminals (see Fig. 3). The wires from the "Speed" knob (terminal No. 5, 7 and 9) should be run in separate conduit.

If the connections between the motor and the controller are made as they are shown on the interconnection diagram (Fig. 2), the motor will turn in the counterclockwise direction when you look at it from the commutator end. If

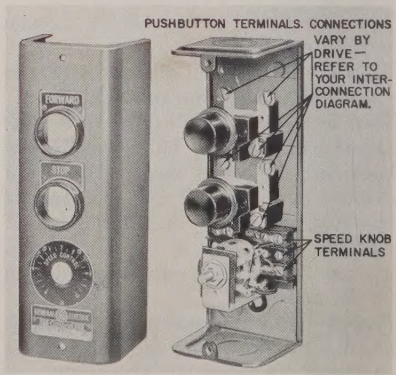


Fig. 3. Thymotrol control station.

you want it to turn the other way, interchange leads (A1) and (A2) at the motor only. See Fig. 2 for terminal numbering.

REPLACE REMOVABLE PANEL

Carefully replace the removable panel, holding it by the shelf. Line up the "teeth" with the openings in the terminal board, then slip the keyhole slots over the retaining screws. Press down firmly on the shelf until the "teeth" are securely seated in the terminal board. For proper contact, no more than $\frac{1}{16}$ inch of the openings between the teeth should be visible.

MAKE PROPER LINE VOLTAGE CONNECTION

Move wire No. 6-4, which comes to top of the line voltage connection board, (H) in Fig. 18, and connect it to the correct terminal for the actual line voltage which you will normally have at the terminals of the controller. Note 1 in Fig. 2 tells you which terminal to connect to for your line voltage. If your line voltage changes, make the connection for the voltage you have most of the time. Proper connection makes for longer tube life. If there is a permanent change in line voltage made at some time, reconnect wire No. 6-4.

INSTALL TUBE

BE SURE POWER IS OFF.

On controllers rated ¼-hp maximum, the tube mounts in a socket and can only be installed one way because of the size of the pins. On controllers of higher ratings, look at the base of the tube where the leads enter the base, (A) in Fig. 4, and note which lead is F −, which is F+ and which is G. Then mount the tube by loosening the retaining screws, as shown in (B) Fig. 4, and sliding the slotted bracket behind the screw heads. Tighten the screws securely. Now connect the tube leads properly to the tube connection terminals, (C) in Fig. 4.

DO NOT CONNECT ANODE CAP (D) YET.

Check all connections and be sure they are tight.

GIVE TUBE INITIAL WARM-UP

Apply power to the drive by closing the line switch, and leave the power applied for at least 15 minutes. Note that the tube gets warm. THIS MUST BE DONE ANY TIME A TUBE IS INSTALLED TO INSURE MAXIMUM TUBE LIFE. Remove power by opening the line switch. Place the anode cap on the anode, (E) in Fig. 4, at the top of the tube (or connect the anode lead to the terminal if the tube is a C16J or equivalent). The drive is now ready to operate.

OPERATION

INITIAL OPERATION

Apply power to the drive by closing the line switch. Turn the "Speed" knob counterclockwise to its minimum setting. Wait at least 60 seconds (30 seconds for a GL6011 tube) for the tube to warm up. (If you ordered your drive equipped with a protective timer, pressing the "Start" button will not start the motor until the tube has heated sufficiently.) Following warm-up, press the "Start" button. You should hear a click in the controller as the motor contactor picks up. Turn the "Speed" knob clockwise slowly. ***If you have made all connections properly,*** the motor will gradually gain speed. Turning the knob in the other direction should reduce the speed.

NORMAL OPERATION

Once you are sure you have made all connections correctly, and the drive is operating properly, you can start the drive with the "Speed" knob set at any speed you wish. The motor will start properly and come up to the speed you have set. You can stop the motor when it is running at any speed simply by pressing the "Stop" button. Unless you ordered your drive without dynamic braking, the motor will be braked quickly to a stop.

Changes in load on the motor up to its rated load will not change the motor speed by more than three percent of its rated base speed, because the electronic

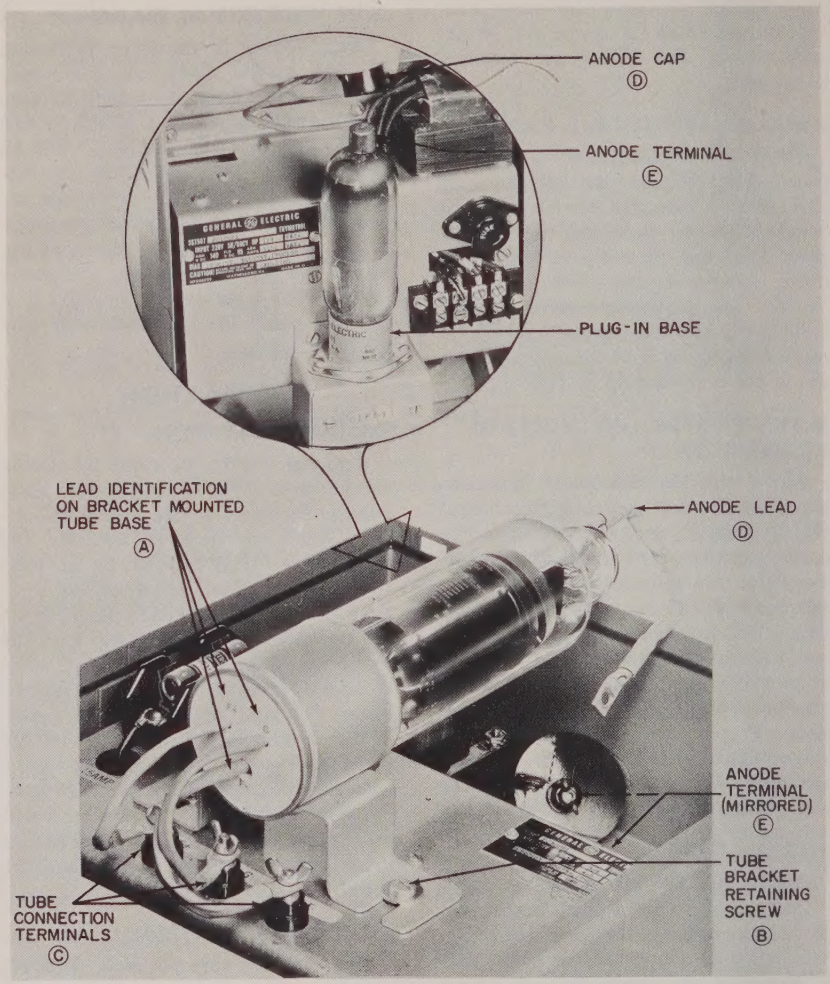


Fig. 4. Tube installation.

controller corrects quickly and automatically for changes in load.

Changes in line voltage and changes in motor temperature may change the speed of the motor.

MAINTENANCE

PREVENTIVE MAINTENANCE

Use an ounce of prevention! Inspect the drive regularly; once a month is reasonable.

MOTOR

Inspection and Lubrication of the Motor

Make sure that the motor mounting bolts are all tight. A loose mounting bolt can cause considerable noise and may result in excessive wear.

Inspect the commutator, the brushes, the brush contact surfaces, and the brush springs. A rough commutator may often be detected by the sound of the

motor. Inspect the commutator for color and condition. It should be clean, smooth, and a polished brown color where the brushes ride. A blue color indicates overheating.

Roughness of the commutator should be removed by sandpapering or stoning (never use emery cloth or emery stone). For this operation, run the motor without load. If sandpaper is used, wrap it partly around a wood block. Press the sandpaper or stone against the commutator with moderate pressure while the motor is running and move it back and forth across the commutator surface.

WARNING: Be careful not to come in contact with live parts.

If the commutator is found to be dirty when the motor is inspected, it should be wiped clean with a piece of canvas or other cloth that is free from lint.

Brush inspection is important. The first essential requirement for the satisfactory operation of brushes is free movement of brushes in the holders.

Check the brushes to make sure that they will not wear down too far before the next inspection. When new brushes are installed, they should be permitted to run without load long enough to assure a good fit.

Make sure that each brush surface in contact with the commutator has the polished finish that indicates good contact, and that the polish covers essentially all of the brush surface. Check the freedom of motion of each brush in its holder. Check the springs that hold the brushes against the commutator. Improper spring pressure may lead to commutator wear and sparking. The correct spring pressure is 2 to 2½ pounds-per-square-inch of brush in contact with the commutator.

The simplest and most important part of motor maintenance is lubrication. This motor has ball bearings which are packed at the factory with grease sufficient for two years of normal operation. At the end of that time, the bearings should be thoroughly cleaned of the old grease and repacked about one-third full with General Electric ball-bearing grease.

CONTROLLER

Look inside the enclosure and be sure it is free of dust, chips, oil or other foreign matter.

REPAIRS

MOTOR

The motor can be repaired like standard d-c motors by any competent motor repairman. If an overload relay trips repeatedly, fuses blow often or the motor shows signs of overheating, check the motor for possible overload. If the motor shows signs of overheating and the fuse is still intact, check the calibration of the overload relay if your drive has one. Fuses are supplied in accordance with the fuse manufacturer's rating and normally protect the motor against damage due to overheating. If the fuse does not blow when the motor overheats, replace the fuse with another of the same rating.

CONTROLLER

Your controller is designed so it can be repaired by any competent electrician. It requires no special test equipment. The basic controller consists of only three fundamental parts (see Fig. 5): the tube, the printed-circuit assembly and the transformer. The latter two are designed to give you many years of trouble-free operation; the tube will have to be replaced at intervals depending on the conditions of operation. Many users report their tubes last for years.

If your motor will not run—

1. Be sure all connections are made and tight. Be sure panel is plugged tightly into terminal board.
2. Be sure power switch is closed.
3. Check the fuse. If it is blown, replace it. If it blows again, look for an overload on the motor or a short circuit.
4. Check the tube. It should have a purple glow after you push the "Start" button. If it does not, hold your hand near it and see if it is warm. ***Be careful***

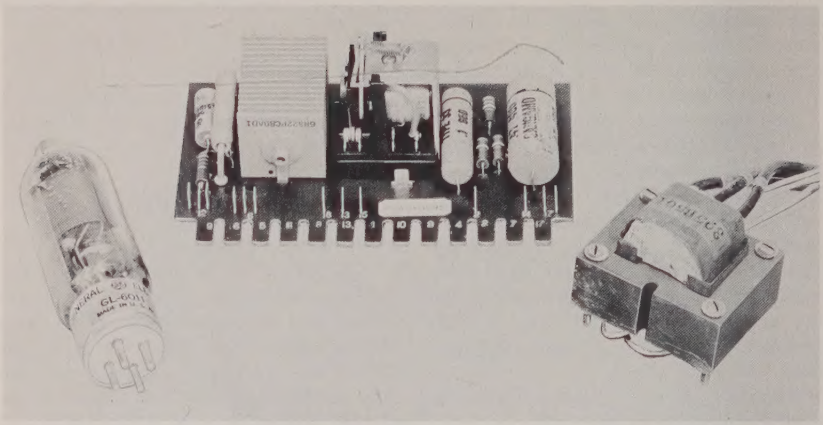


Fig. 5. The three fundamental units of the half-wave Thymotrol controller.

not to touch live parts. If it does not glow or is not warm, replace it with a new one. Refer to installation instructions on page 5.

5. If a new tube does not get warm, and you are sure all connections are tight, replace the transformer. The likelihood of transformer trouble is very remote, but instructions are included below anyway.

6. If the new tube gets warm, but does not glow, and you are sure all connections are tight and the panel is seated firmly in the terminal board, replace the printed-circuit assembly (see instructions below).

If your motor runs faster or slower than normal for a given setting of the speed control,

1. Check your line voltage to be sure it is normal.
2. Try a new tube. (See installation instructions on page 5.)
3. If the drive acts the same way with a new tube, replace the printed-circuit assembly (see below).

If the motor runs at full speed and cannot be controlled by the speed control,

1. Check all connections for poor connections or short circuits.
2. Try a new tube. (See installation instructions on page 5.)
3. If the drive acts the same way with a new tube, replace the printed-circuit assembly (see below).

If the speed varies for a given setting of the speed control,

1. Check for variations in line voltage.
2. Check for variations in motor load or possible overload.

REPLACING PRINTED-CIRCUIT ASSEMBLY

1. Disconnect power from drive.
2. Loosen panel retaining screws.
3. Press down on the handle, ejecting panel. Carefully lift the panel out of the enclosure.
4. Be sure you can read the numbers on all the wires which connect to the tabs on the printed-circuit assembly. If dirt has obscured them, tag the wires so you will be able to replace them on the proper tabs.
5. Slide the terminals off all tabs, using long-nosed pliers.
6. Slide the printed-circuit assembly out of the neoprene mounting strips.
7. Slide the new assembly into place in the mounting strips.
8. Slide the terminals of the wires on the proper tabs by pressing straight down, using long-nosed pliers. Don't try to wiggle them on; you might damage them (see Fig. 6).

9. Replace the panel in the enclosure as described on page 4. The printed-circuit assembly can probably be repaired by a skilled technician. Return the assembly to the factory for repair after calling your General Electric Apparatus Sales Office for return instructions. If facilities and skilled technicians are available to locate and replace components which have failed, order the parts by their individual catalog numbers. (Appendix A gives a detailed description of circuit operation; Appendix B gives instructions for repairing the printed-circuit assembly; and a renewal parts list is included with this book.)

REPLACING TUBE

To replace the tube, follow the same procedure as for installation of the tube, page 5. To obtain replacement tubes, see your nearest General Electric Tube Distributor as listed on the decal inside the controller.

REPLACING TRANSFORMER

1. Disconnect transformer lead 1 from the fuse holder by unsoldering or unscrewing it (depending on the size panel you have).

2. Unscrew transformer leads 2, 3, 4 and 5 from the terminal board on the front of the panel.

3. Disconnect transformer leads 6 and 8 from the terminals marked F+ and F− or from the tube socket if the panel has one.

4. Slide the terminal on transformer lead 7 off tab terminal 2 on the printed-circuit assembly.

5. Remove all transformer leads from the wire harness by unlacing where necessary.

6. Remove the transformer mounting screws and nuts, and replace the transformer with a new one. Make connections in the same way they were made on the original.

MODIFICATIONS AND ACCESSORIES

The following paragraphs describe some of the most common modifications and accessories used with these Thymotrol drives. Always follow the preceding instructions on your basic drive. If you

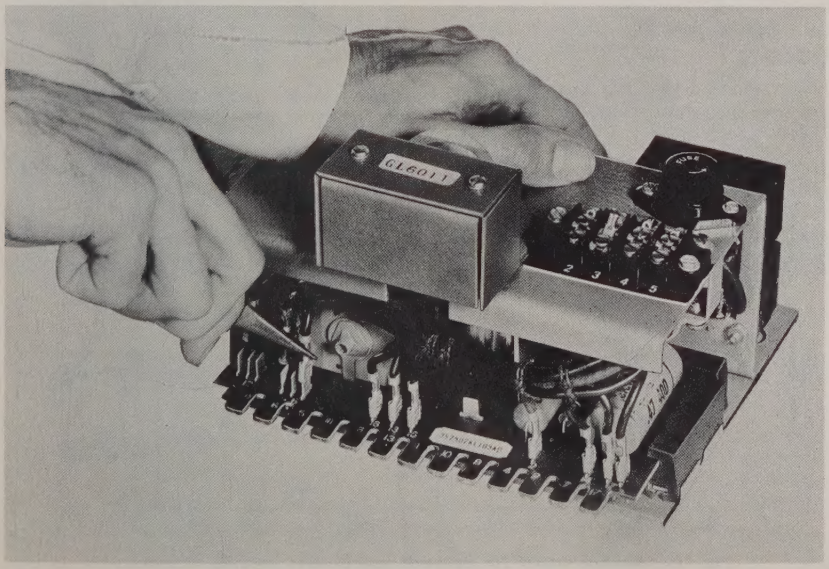


Fig. 6. Sliding wire terminals on printed-circuit board.

ordered modifications or accessories, the diagrams you received with your equipment tell you how to connect it and the details of the circuit. Be sure you follow them carefully.

TRANSFORMERS

For nominal line voltages other than 220 volts, or when you wish to isolate your drive from the power line, you must use a transformer. The connections for the transformer are shown on the instructions furnished with the transformer.

REVERSING

The function of reversing is accomplished by adding a reversing contactor to the standard drive and substituting a reversing control station for the one normally furnished with the standard drive. Figures 7 and 8 show the control and motor armature circuits as they normally appear in a typical reversing drive.

To connect your drive for reversing operation, be sure to remove the two red wires between terminals 6 and 17 and between 1 and 2 in the controller as directed on the interconnection diagram.

JOGGING

By switching to JOG, you can make your motor run only while you hold the "Start" button down; it will stop when you release the button.

In one jogging arrangement, pressing the "Start" button will jog it at the speed set on the regular "Speed" knob. Figure 9 shows the control circuit for this arrangement in a non-reversing drive; Fig. 10 shows the circuit for a reversing drive.

In another arrangement, the drive contains a separate Jog Speed control

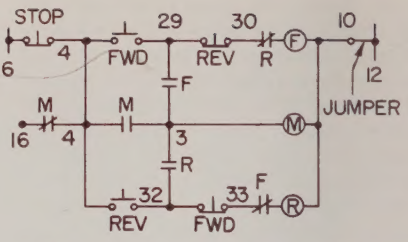


Fig. 7. Control circuit for reversing operation.

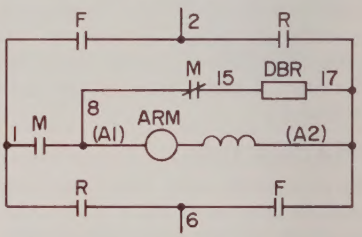


Fig. 8. Armature circuit for reversing operation.

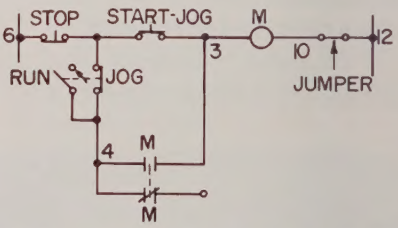


Fig. 9. Control circuit for jogging forward only at main speed potentiometer setting.

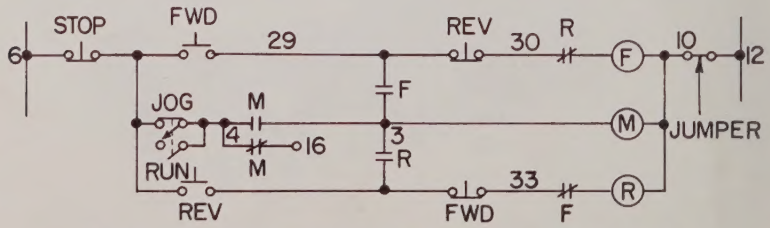
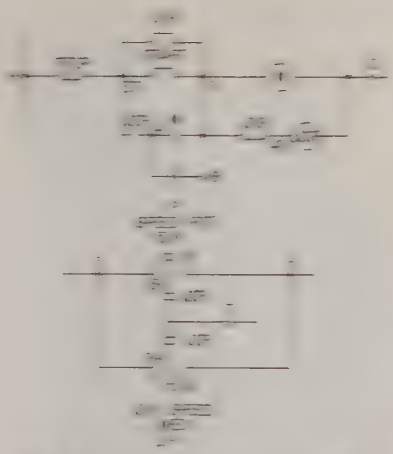
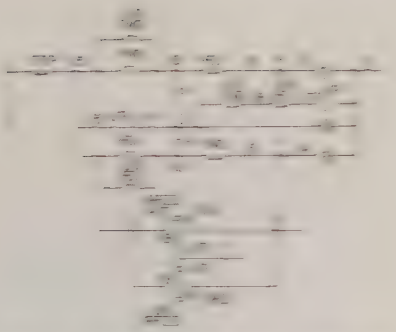


Fig. 10. Control circuit for forward and reverse jogging at main speed potentiometer setting.



NOTE: For complete elementary (see diagram above) with zones. Circuits other than those shown above remain the same. Breaquire circuits in place of those shown above in the diagram marked with zones.

Fig. 9. Lamps which be removed by a reservoir cap seal.



NOTE: For complete elementary (see diagram above) with zones. Circuits other than those shown above remain the same. Breaquire circuits in place of those shown above in the diagram marked with zones.

Fig. 8. Lamps which be removed by a reservoir cap seal.

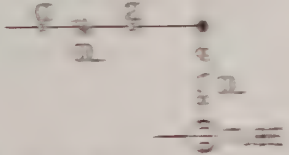


Fig. 10. Addition of overload relay

OVERLOAD RELAY

If the system must have overload protection, a thermal overload relay may be added as shown in the sketch in Fig. 10. If the overload relay trips, interrupting the coils of the contactors in the motor side of the starter, the entire system will be shut down. In the event a push button station is used to start the motor, an additional holding contact around the push button must be added.

PROTECTIVE TIMER

If the system must have protection against the "jam" which may occur in the drive unit, or run for a definite length of time, a timer may be used. This type of control is known as a definite time relay. The timer is shown in Fig. 11.

Fig. 11. Addition of protective timer.

PRINCIPLES OF OPERATION

The following brief discussion is intended to provide a general understanding of the circuit operation.

One of the simplest circuits for speed control of a d-c motor is shown in Fig. 15. The cathode of the thyratron is at a positive potential equal to the instantaneous armature voltage with respect to the minus terminal of the armature. The thyratron grid is at a positive potential equal to some portion of the battery voltage as set by potentiometer 1P. During the portion of the cycle before the thyratron conducts, the cathode potential is the counter electromotive force of the motor which is a direct measure of motor speed assuming the field excitation is constant. During any half-cycle when the thyratron anode is positive, if the grid voltage is above the counter emf, the thyratron will pass current. (The assumption is made here that the critical grid voltage of the thyratron is zero. This assumption is accurate enough for purposes of this explanation.) This current flowing through the armature conductors produces a torque which accelerates the motor again.

When the motor reaches a speed at which the counter emf exceeds the grid voltage, the thyratron will not conduct, and the motor will coast until the counter emf again drops below the grid voltage. From this it is seen that the motor speed oscillates about a speed at which the counter emf is equal to the grid voltage as determined by potentiometer 1P.

The principal disadvantage of this circuit is that either current passes for a complete half cycle or it does not pass at all. This means that torque pulsations are severe and unequally spaced.

The circuit of Fig. 16 permits the thyratron to conduct for a portion of every positive half cycle. The angle of conduction is automatically set so that for any given load on the motor, equal pulses of current are passed each cycle.

In this circuit a small a-c voltage is placed in the grid circuit in series with the d-c voltage from potentiometer 1P. This a-c voltage is shifted so that it lags the thyratron anode voltage about ninety degrees in time. By such a means, when the counter emf of the motor is exactly equal to the voltage set on the slider of potentiometer 1P, the grid becomes positive with respect to the cathode ninety degrees after the anode voltage goes positive.

If the counter emf rises or drops by an amount equal to the peak of the a-c grid voltage, the intersection of the grid and cathode (or firing point) will be moved backward or forward with respect to the anode voltage over the complete range of positive anode voltage. Thus, since the a-c portion of the grid signal is small, a small change in motor speed can control the thyratron from fully on to completely off. For any given load and speed, a balance point is reached where just enough current is passed during each cycle to maintain that speed until the next cycle.

A typical elementary diagram of the actual 3S7507FC circuit is shown in Fig.

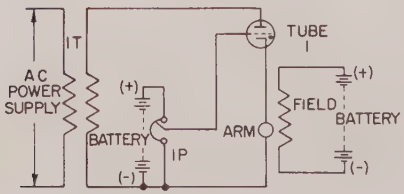


Fig. 15. Basic control circuit with d-c grid voltage.

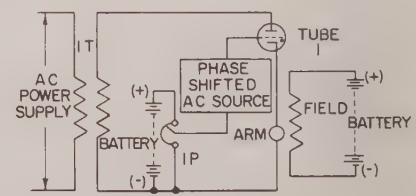


Fig. 16. Basic control circuit with a-c and d-c grid voltage.

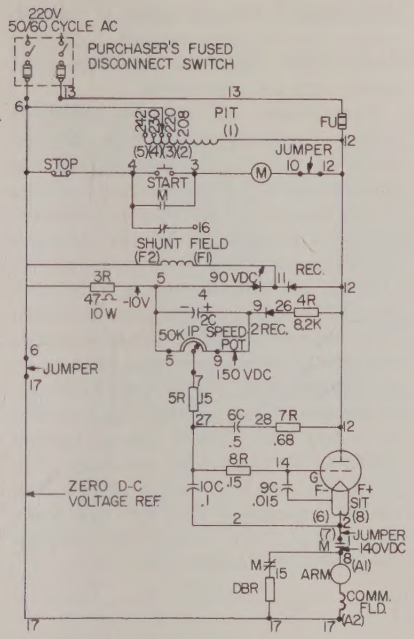


Fig. 17. Elementary diagram of basic 357507FC Thymotrol controller.

17. The panel consists essentially of a thyratron tube and associated grid phasing circuitry to rectify and control the motor armature voltage, a selenium rectifier circuit, utilizing 1REC, to supply the motor shunt field, and a selenium rectifier circuit, utilizing 2REC, to supply the d-c speed reference voltage. Fuse FU is a thermal fuse which, while permitting starting current surges, will blow if excessive current persists.

During one-half cycle of voltage the shunt field is supplied directly from the a-c line through part of rectifier 1REC. During the next half-cycle, the remaining half of rectifier 1REC provides a flow path for the current produced by the collapse of the flux lines in the motor field. These combined effects allow current to flow during the entire cycle providing a low ripple d-c supply for the field.

The armature tube phasing circuit is of the a-c plus d-c type, similar to that discussed in conjunction with Fig. 16.

The control signal applied to the grid of the thyratron tube is composed of the following:

1. An a-c voltage from the line.
2. A d-c reference voltage from speed control potentiometer 1P.
3. The back electromotive force or generated voltage of the motor.

A 90 degree phase shifted voltage is obtained directly from the line through a double RC circuit consisting of resistor 7R, capacitor 6C, resistor 8R, and capacitors 9C and 10C. The result is that the voltage between points 14 and 2 is an a-c voltage lagging the anode voltage of the tube by approximately 90 degrees.

A source of speed reference voltage is obtained from the externally mounted speed control potentiometer 1P which is connected in series with a limiting resistor 4R and rectifier 2REC, and across capacitor 2C. Resistor 3R is required to obtain a negative bias below bus 6 for the purpose of supplying the speed potentiometer with the negative voltage needed to adjust speed down to zero. The −10 volts for point 5 is a nominal value. It will vary with motor size.

When the counter electromotive force of the motor is exactly equal to the voltage set on the slider of potentiometer 1P, the grid becomes positive with respect to the cathode, 90 degrees after the anode voltage goes positive. (This assumes that the critical grid voltage of thyratron is zero, which is sufficiently accurate for the present explanation.)

If the counter electromotive force rises or drops by an amount equal to the peak of the a-c grid voltage, the intersection of the grid and cathode voltage (or firing point) will be retarded or advanced with respect to the anode voltage over the complete range of positive anode voltage. This circuit regulates speed as follows:

Reference voltage is supplied between terminals 17 and 7 with terminal 7 positive. This reference voltage acting in conjunction with the 90 degree phase-shifted grid voltage phases the thyratron tube on and causes the motor armature

to turn with the result that a back voltage is developed across the armature. The polarity of this voltage is positive at terminal 8 with respect to terminal 17. The effect of this armature voltage in the regulating circuit is to turn off, or to tend to turn off, the armature tube. A balance will be achieved at the point at which the armature voltage is essentially equal to the speed reference voltage with the difference being just sufficient to cause the 90 degree phase shifted voltage to fire the tube at the point necessary to maintain that particular armature voltage. Since the tube always goes out at some time during the negative half-cycle, the voltage appearing across the armature at the time the tube is to be refired is the counter electromotive force of the motor, which is a direct measure of motor speed (assuming the field excitation is constant). Therefore, for any given load and speed a balance point is reached where just enough current is passed during each cycle to maintain that speed until the next cycle.

Transformer 1T provides filament voltage for the thyratron tube. Adjustment of taps on the primary of this transformer provides a constant voltage on the filament of the tube for different a-c line voltage levels. This is necessary for maximum life of the thyratron tube.

When the stop button is depressed, the "M" contactor coil circuit is broken. This causes the "M" contact in series with the thyratron tube to open, removing power from the armature circuit. At the same time, another "M" contact (in series with DBR) closes, placing DBR across the motor armature. The DBR acts as a load on the "motor now turned generator." This acts as a brake to dissipate the energy of rotation (inertia), stopping the motor.

SERVICING PRINTED CIRCUITS

In repairing printed-circuit assemblies, rather than to attempt to replace certain defective components, it is sometimes better to replace the complete assembled printed circuit board unit. A relay, for example, is a rigid component attached to the printed board by as many as eight soldered connections. The difficulty that can be encountered in attempting to unsolder eight separate points simultaneously is obvious. If an emergency requires that such multi-tab components be replaced, they can be. Care must be taken, however, to prevent damage to the board.

Other components, however, such as resistors and capacitors, for example, can be replaced easily and with a minimum of effort if proper techniques are used. Should the person making the repairs become careless, or use improper techniques, however, he can overheat the board. Excess heat can cause the wiring pattern to blister or loose its adhesion to the board.

CIRCUIT TRACING AND CHECKING

Circuit tracing on a printed-circuit board is simpler than conventional wiring because the circuits are visible and neatly laid out. Often parallel paths can be opened by merely disconnecting leads coming to terminals on the board, and the condition of individual components can be checked "in place." Voltage or resistance measurements can be made by contacting either the component leads or the printed conductors. If a protective varnish is used on the printed board, the person making the checks should be certain that good instrument contact is being made. He can penetrate the varnish with a sharp meter probe, or scrape it away with a sharp knife, being careful not to damage the foil conductors.

REPLACING COMPONENTS

Defective components with terminal leads usually can be replaced without

removing the printed-circuit board from its mounting by one of the following methods:

1. If the component leads are long enough for a replacement component to be soldered to them, the leads of the defective component should be cut where they enter the component. The leads should then be straightened out perpendicular to the printed-circuit board. The leads of the replacement component are then cut and a small loop made in the leads of such size that they can be placed directly over the remaining upright leads of the defective component. The new component should then be quickly soldered in place using low temperature solder. The soldering iron heat should not be applied too long for the heat transferred through the leads might melt the solder joint to the printed-circuit board itself.

2. Should the leads not be long enough, additional length (formerly inside component) can probably be obtained by crushing the defective component. Enough additional lead length should be obtained by this action to make repairs by method (1) possible.

3. In some cases it may be desirable to remove both the defective component and its leads. Often component leads are inserted through the holes of a printed-circuit board and the excess length cut off in such a way that the lead end is pressed flat. This prevents its withdrawal from the hole into which it was inserted, thus assuring that the components are "in place" before the solder operation takes place.

Defective components so attached, however, are easily removed if the component leads are cut (using diagonal wire cutters) and the remaining short sections of component lead removed from the foil side of the printed-circuit board.

With a small pencil-type soldering iron of no more than 35 watts, heat the connection on the printed wiring side of the board and remove the leftover component leads. When the solder melts, wipe it away with a small cloth. Be careful not to create short circuits by wiping solder from one conductor to another. Do not leave the soldering iron on the board while wiping the solder. Simply melt the solder, remove the soldering iron and quickly wipe the excess solder away. Component leads on the replacement part must then be formed and the component soldered in place. Again, a small soldering iron and low temperature 60–40 solder should be used.

Should any of the printed wiring become broken, lifted, or otherwise damaged, it may be replaced or paralleled by a length of standard hook-up wire.

Remember that printed wiring is nothing more than a copper conductor clinging to an insulating board. A cautious and swiftly executed approach to repairing damaged portions of the printed-circuit board will yield satisfactory and lasting results.

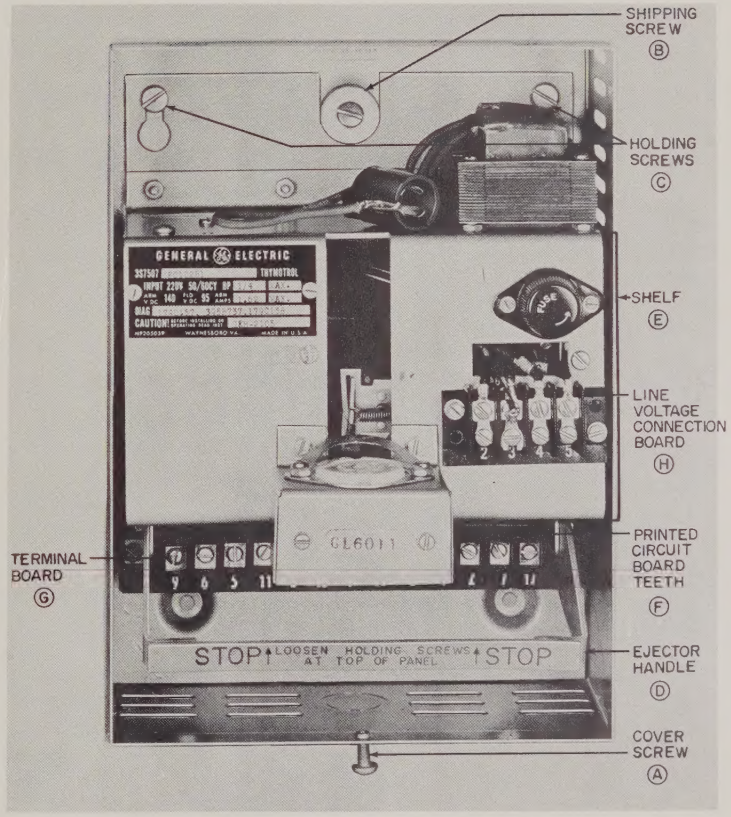


Fig. 18. Half-wave Thymotrol drive controller.

PRINCIPAL RENEWAL PARTS

LIST FOR 3S7507FC THYMOTROL PANELS

QUANTITY USED	CAT. NO. 3S7507FC102A1	CAT. NO. 3S7507FC202A1	CAT. NO. 3S7507FC302A1	DESCRIPTION	DIAGRAM SYMBOL
1	395B501	233B968	233B968	Transformer	IT
1	571A477G13	571A477G13	571A477G13	Terminal Board	
1		"See Fuse List Below"		Fuse	
1	8277646G15	8277646G15	8277646G15	Capacitor	9C
1	9729440D75	9729440D39	9729441D13	Resistor	DBR
1	GL6011	*	GL5665/C16J	Tube	
1	9779249	None	None	Socket	
1	**	**	9729483	Relay	M
1	3S7507KL105A1	3S7507KL105A1	3S7507KL110A1	Control Unit	

* For 1/3 HP drives use GL6857/740P tubes.
For 1/2 HP drives use GL6808 tubes.
** Relay M is contained on control unit 3S7507KL105A1 printed circuit board. If this relay is found to be defective, it is recommended that the entire printed board control unit be replaced.

FUSE LIST

H.P.	PART NUMBER	AMPERES
1/50	9770381P1	1.0
1/40	9770381P1	1.0
1/30	9770381P10	1.25
1/20	9770381P11	1.6
1/12	9770381P12	2.0
1/10	9770381P12	2.0
1/8	9770381P13	2.5
1/6	9770381P14	3.2
1/4	9770381P15	4.0
1/3	9770381P17	6.25
1/2	9770381P18	8.0
3/4	933B519P24	10.0
1	933B519P26	15.0

RENEWAL PARTS

FOR CONTROL UNITS 3S7507KL105A1, 3S7507KL110A1

QUANTITY USED	CAT. NO.	DESCRIPTION
1	9729459P2	Relay (M) (Not on 3S7507KL110A1)
1	561A699	Rectifier (1 Rec.)
1	6RS5GH20TH1	Rectifier (2 Rec.)
1	8622212D47	Resistor 47 ohm 10 watt (3R)
1	6986159F82	Resistor 8.2K ohm 1 watt (4R)
2	6986159H15	Resistor .15 megohms 1 watt (5R, 8R)
1	6986159H68	Resistor .68 megohms 1 watt (7R)
1	9774722J40	Capacitor 40 mfd. (2C)
1	8277647H47	Capacitor .47 mfd. (6C)
1	8277646H10	Capacitor .1 mfd. (10C)

Renewal Parts

PRINCIPAL RENEWAL PARTS

DESCRIPTION OF ASSEMBLY OR PART	ORDERING NUMBER	MODEL NUMBER 3S7507FC -100B1 or -101B1	-102B1 or -103B1	-107B1 or -108B1	-200B1 or -201B1	-202B1 or -203B1	-205B1 or -206B1	-207B1 or -208B1	-209B1 or -210B1	-217B1	-218B1	-219B1	-300B1 or -301B1	-302B1 or -303B1	-304B1	-305B1 or -306B1	-307B1 or -308B1	-309B1 or -310B1
		NO. IN USE			NO. IN USE								NO. IN USE					
RESISTOR (DBR)	9729440D75	0	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	9729440D39	—	—	—	0	1	1	1	1	0	0	0	—	—	—	—	—	—
	9729441D13	—	—	—	—	—	—	—	—	—	—	—	0	1	0	1	1	1
TIMER ASSEMBLY	ORDER BY DESCRIPTION	0	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	3S7507MA108A1	—	—	—	0	0	0	1	1	1	1	1	0	0	0	0	1	1
OVERLOAD RELAY LESS HEATER (ORDER HEATER ACCORDING TO CAT. NO. STAMPED ON HEATER IN USE)	CR2824-41L	0	0	0	0	0	1	0	1	0	1	0	0	0	1	1	0	1
BASIC CONTROL UNIT	3S7507KF115B1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
LESS THE ABOVE PARTS,	3S7507KF116B1	—	—	—	1	1	1	1	1	1	1	1	—	—	—	—	—	—
AND LESS ENCLOSURE	3S7507KF117B1	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1
TRANSFORMER (IT)	395B501	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	233B968	—	—	—	1	1	1	1	1	1	1	1	—	—	—	—	—	—
	233B967	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1
CAPACITOR (9C)	8277646G15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RELAY (M)	9729483	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1
COMPLETE PRINTED-CIRCUIT BOARD	*3S7507KL105A2	1	1	1	1	1	1	1	1	1	1	1	—	—	—	—	—	—
	*3S7507KL110A2	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1

* It is recommended that printed-circuit boards be returned to the factory for repairs but users who have facilities to determine and replace damaged parts may order them as follows:

Rectifier (1REC)	124A1826
Rectifier (2REC)	6RS5GH20TBH1
Capacitor (2C)	9774722J40 (4 mfd)
Capacitor (6C)	8277647H47 (.47 mfd)
Capacitor (10C)	8277646H10 (0.1 mfd)
Resistor (3R)	8622212D47 (47 ohms)
Resistor (4R)	6986159F82 (8200 ohms)
Resistors (5R, 8R)	6986159H15 (.15 megohms)
Resistor (7R)	6986159H68 (.68 megohms)
Relay (M)	9729459P2 (Used on 3S7507KL105A2 only)

SPECIALTY CONTROL DEPARTMENT

GENERAL ELECTRIC

WAYNESBORO, VA.

10-60 (5700)